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The Quantity Approach to Financial Integration: The Feldstein-Horioka Criterion Revisited

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Abstract

This paper applies the Feldstein-Horioka criterion, that is, the role of savings-investment correlations, to assess the degree of financial integration in the European Community. We establish a link between the Feldstein-Horioka criterion and three other criteria for financial integration: the covered, uncovered, and real interest parity condition. Subsequently, we evaluate the Feldstein-Horioka criterion for financial integration on the basis of its underlying assumptions. The paper performs both cross-section and time-series analyses of savings-investment correlations. The time-series analysis relies on the concept of cointegration. Our major finding is that the Feldstein-Horioka criterion—contrary to what is usually found in world financial markets—is able to explain an increasing degree of financial integration in the European Community.

This paper deals with a theoretical and empirical analysis of the extent of financial integration in the European Community (EC). The measurement of financial integration in the EC relies on the Feldstein-Horioka (F-H) criterion, which originated in 1980 when Feldstein and Horioka asserted that one could deduce from the national accounting framework the degree of financial integration. By examining the correlation between national savings and domestic investment, Feldstein and Horioka were able to quantify the degree of financial integration. F-H hypothesize that changes in gross national savings and/or gross domestic investment may generate changes in the current account balance. In a perfectly integrated financial market, a current account deficit (surplus) will be balanced by a corresponding capital inflow (outflow) and a country's savings decisions will be separated from its investment decisions. It is this criterion for financial integration that we will address in this paper. This paper develops additional evidence on the integration of European financial markets. Contrary to what is usually found in world financial markets, savings-investment correlations in the EC are relatively small.

Although, the F-H criterion is controversial, it may provide evidence of an increasing degree of financial integration in the EC. With the enforcement of the Single European Act on July 1, 1987 the member states of the European Community (EC) confirmed the objective of the realization of an Economic and Monetary Union on

January 1, 1999 at the latest. Since then, the pace of financial integration in the EC has rapidly increased. Following the Single European Act, the European Commission enacted on June 24, 1988 a directive to lift all restrictions on short-term and long-term capital movements. This means that as of July 1, 1990 the first phase of the European Economic and Monetary Union was started. We expect potential capital flows within the EC to increase. However, the impact on actual capital flows is ambiguous.

This paper is organized as follows. In section 2 we discuss three alternative criteria for financial integration: the covered, uncovered, and real interest parity condition. We establish a link between these interest parity conditions and the F-H criterion. Furthermore, we evaluate the F-H criterion for financial integration on the basis of its underlying assumptions. Section 3 applies the F-H criterion for financial integration to two cross-sectional samples of EC countries. In section 4 we employ the concept of cointegration to ascertain the existence of a long-run equilibrium relationship between savings and investment ratios of individual EC countries. Section 5 concludes the paper.

1. Interest parity conditions

The F-H criterion is related to three interest parity conditions that correspond to three different criteria for financial integration put forward in the literature. Table 1 summarizes algebraically the three different interest parity conditions and the F-H criterion. In addition, Table 1 sets out the cumulative assumptions to be fulfilled for each condition to hold. Interest parity conditions examine different types of perfect capital mobility. Perfect capital mobility of a particular type is taken to be the joint hypothesis that domestic and foreign bonds, identical in all respects apart from their currency denomination, are *perfect substitutes* and that arbitrage continually ensures the interest parity condition to hold. The objective of arbitrage is to allocate funds between financial markets in order to realize the highest possible return, subject to the least possible risk. Note that the first three criteria in Table 1 rely on the comovement of domestic and foreign *prices* (i.e.; interest rates) and fit into the price approach. Criterion IV, however, relies on the comovement of domestic *quantities* and fits into the quantity approach (see Feldman 1986).

The first criterion—covered nominal interest rate parity (CIP)—examines perfect capital mobility of type I. If CIP holds, the forward premium/discount $[f_t^{t+k} - s_t]$ equals the difference between the domestic and foreign nominal interest rate at the appropriate maturity $[i_t - i_t^*]$. Investors cover themselves in the forward exchange market. The first criterion can be framed in terms of the decomposition method of Frankel and MacArthur (1988). Perfect capital mobility of type I requires a zero covered nominal interest differential, or in other words a zero country premium $[i_t - i_t^* - (f_t^{t+k} - s_t)]$. The country premium captures the impact of actual and future capital controls, default risks, and transactions costs.

The second criterion—ex ante uncovered nominal interest parity (UIP)—examines perfect capital mobility of type II. Investors take open positions in the foreign

Table 1. Four criteria for perfect capital mobility and their cumulative assumptions[a]

I Covered nominal interest rate parity (CIP)	
Assumption:	
$i_t - i_t^* = f_t^{t+k} - s_t$	(CIP)
Yields:	
$i_t - i_t^* = f_t^{t+k} - s_t$	(CIP)
II Ex ante uncovered nominal interest rate parity (UIP)	
Assumptions:	
$i_t - i_t^* = f_t^{t+k} - s_t$	(CIP)
$E_t(s_{t+k}) = f_t^{t+k}$	(Forward exchange rate is an unbiased predictor of expected future spot exchange rate)
Yields:	
$i_t - i_t^* = E_t(s_{t+k} - s_t)$	(UIP)
III Ex ante real interest rate parity (RIP)	
Assumptions:	
$i_t - i_t^* = f_t^{t+k} - s_t$	(CIP)
$E_t(s_{t+k}) = f_t^{t+k}$	(Forward exchange rate is an unbiased predictor of expected future spot exchange rate)
$E_t(s_{t+k} - p_{t+k} + p_{t+k}^*) = s_t - p_t + p_t^*$	(Zero expected real exchange rate change)
Yields:	
$E_t(r_{t+k}) = E_t(r_{t+k}^*)$	(RIP)
IV Feldstein-Horioka criterion (F-H criterion)[b]	
Assumptions:	
$I_{i,t+k}/Y_{i,t+k} = -\phi E_t(r_{i,t+k}) + \mu_i$	
and	
$i_t - i_t^* = f_t^{t+k} - s_t$	
$E_t(s_{t+k}) = f_t^{t+k}$	$\mathrm{Cov}(E_t(r_{i,t+k} - r_{i,t+k}^*), S_{i,t+k}/Y_{i,t+k}) = 0$
$E_t(s_{t+k} - p_{t+k} + p_{t+k}^*) = s_t - p_t + p_t^*$	
$\mathrm{Cov}(\mu_i, S_{i,t+k}/Y_{i,t+k}) = 0$	
$\mathrm{Cov}(E_t(r_{i,t+k}), S_{i,t+k}/Y_{i,t+k}) = 0$	
Yields:	
$I_{i,t+k}/Y_{i,t+k} = \alpha + \beta(S_{i,t+k}/Y_{i,t+k}) + \epsilon_{i,t+k}$	

Symbols:

- i_t = domestic nominal rate of interest at time t on a k-period bond held between time t and t + k
- f_t^{t+k} = forward exchange rate agreed at time t for the delivery of foreign currency at time t + k
- s_t = spot exchange rate at time t (i.e., domestic currency units per unit of foreign currency)
- $f_t^{t+k} - s_t$ = forward premium (if positive) or discount (if negative) on foreign currency at time t
- $E_t(s_{t+k})$ = expected spot exchange rate at time t + k
- $E_t(s_{t+k} - s_t)$ = expected spot exchange rate change of the domestic currency vis-à-vis the foreign currency between time t + k
- p_t = domestic price level at time t
- $E_t(r_{t+k})$ = expected domestic real rate of interest at time t on a k-period bond held between time t and t + k
- E_t = conditional expectations operator based upon the information available at time t, i.e., $E(.|I_t)$
- μ = a stochastic error term that captures all other determinants of the investment ratio uncorrelated with $E_t(r_{i,t+k})$ and $S_{i,t+k}/Y_{i,t+k}$
- I = gross domestic investment
- S = gross national savings
- Y = gross domestic product
- ϵ = an error term
- k = denotes the holding period of the underlying debt instrument
- * = denotes a foreign variable
- i = denotes country i

Notes:

[a]Table 1 is framed according to the terminology introduced by Frankel and MacArthur (1988) and Frankel (1989). All variables except the interest rates are expressed in natural logarithms. Lower-case letters represent natural logarithms. For example, the exact expression of CIP is $F_t^{t+k}/S_t = (1 + i_t)/(1 + i_t^*)$. We obtain the logarithmic approximation, i.e., $i_t - i_t^* = f_t^{t+k} - s_t$, by taking natural logarithms of both sides of $F_t^{t+k}/S_t = (1 + i_t)/(1 + i_t^*)$ and applying the approximation that $\ln(1 + x) = x$ for small $|x|$ and noting that $f_t^{t+k} = \ln(F_t^{t+k})$ and $s_t = \ln(S_t)$.

[b]For convenience, we apply the cross-section specification of the F-H criterion.

Source: Frankel and MacArthur (1988) and Frankel (1989).

exchange market and are risk neutral. Consequently, we may replace the forward exchange rate by the expected spot exchange rate $[E_t(s_{t+k}) = f_t^{t+k}]$. The expected nominal exchange rate change $[E_t(s_{t+k}) - s_t]$ equals the nominal interest differential at the appropriate maturity $[i_t - i_t^*]$. The second criterion can also be framed in terms of the decomposition method of Frankel and MacArthur. Frankel and MacArthur decompose the UIP differential in the following way: $i_t - i_t^* - [E_t(s_{t+k} - s_t)] = [i_t - i_t^* - (f_t^{t+k} - s_t)] + [f_t^{t+k} - s_t) - (E_t(s_{t+k} - s_t)]$. Perfect capital mobility of type II requires a zero country premium and a zero exchange risk premium $[(f_t^{t+k} - s_t) - (E_t(s_{t+k} - s_t)]$. The exchange risk premium captures the extent to which the forward exchange rate is a biased predictor of the future spot rate.

The third criterion—ex ante real interest parity (RIP)—examines perfect capital mobility of type III, or in other words perfect financial and nonfinancial capital mobility. Nonfinancial capital mobility refers to the mobility of goods and services and the mobility of the production factors labor and physical capital. Ex ante RIP holds if the domestic and foreign real interest rate are equal $[E_t[r_{t+k}) = E_t(r_{t+k}^*)]$. RIP requires not only a zero country premium and a zero exchange risk premium but also a zero expected real exchange rate change $[E_t(s_{t+k} - E_t(p_{t+k} - p_t) + E_t(p_{t+k}^* - p_t^*)]$. This follows from the decomposition of the ex ante real interest differential: $E_t(r_{t+k} - r_{t+k}^*) = [i_t - i_{t,t+k}^* - (f_t^{t+k} - s_t)] + [(f_t^{t+k} - s_t) - (E_t(s_{t+k} - s_t)] + [E_t(s_{t+k} - s_t - E_t(p_{t+k} - p_t) + E_t(p_{t+k}^* - p_t^*)]$. Thus, the third term measures the expected real depreciation of domestic currency, i.e., the extent to which ex ante purchasing power parity is violated. The last two terms together constitute the currency premium.

The CIP and the UIP conditions coincide with two important theoretical aspects of *financial* integration, i.e., the *ability* and the *willingness* to move financial assets across national borders in response to expected differences in exchange-adjusted returns (see, e.g., Boothe et al. 1985, Caramazza et al. 1986, Akhtar and Weiller 1987, Reinhart and Weiller 1987a). Two assets are substitutable if investors are willing to change relative shares of their portfolio in response to a change in expected relative returns. Whether asset stocks actually change depends on the ability of investors to adjust their portfolios.[1] The CIP condition examines the ability of capital movements while the UIP condition examines the ability and willingness of capital movements.

The fourth criterion—the Feldstein-Horioka (F-H) condition—examines perfect capital mobility of type IV. The F-H condition infers from a regression of the national savings ratio $[S_{i,t+k}/Y_{i,t+k}]$ on the domestic investment ratio $[I_{i,t+k}/Y_{i,t+k}]$ the degree of capital mobility of type IV. For perfect capital mobility of type IV to exist, we need a zero coefficient β in the following regression equation: $I_{i,t+k}/Y_{i,t+k} = \alpha + \beta(S_{i,t+k}/Y_{i,t+k}) + \epsilon_{i,t+k}$. The F-H condition requires two additional assumptions to the RIP condition and is therefore the strongest criterion for financial integration. The next section will elaborate on the F-H criterion for financial integration and its underlying assumptions. However, section 2 first establishes a link between above interest parity conditions and the F-H criterion.

2. The link between interest parity conditions and the Feldstein-Horioka criterion

Following Dooley et al. (1987, pp. 505–506), we set out the link between interest parity conditions and the F-H criterion. The F-H criterion infers from the correlation between savings and investment—both expressed as ratios of gross domestic product—the degree of capital mobility of type IV. The F-H criterion needs slightly different assumptions than the ex ante RIP condition. If it is true that in each country i the investment rate depends linearly on the expected domestic real interest rate, that is;

$$I_{i,t+k}/Y_{i,t+k} = -\phi E_t(r_{i,t+k}) + \mu_i \tag{1}$$

and if it is true that the stochastic error term μ_i that captures all other determinants of the investment rate is uncorrelated with the savings ratio in that country;

$$\mathrm{Cov}(\mu_i, S_{i,t+k}/Y_{i,t+k}) = 0 \tag{2}$$

and if the savings ratio is not affected by the expected real foreign interest rate;

$$\mathrm{Cov}(E_t(r^*_{i,t+k}), S_{i,t+k}/Y_{i,t+k}) = 0 \tag{3}$$

and if deviations from real interest parity are uncorrelated with the savings ratio;

$$\mathrm{Cov}(E_t(r_{i,t+k} - r^*_{i,t+k}), S_{i,t+k}/Y_{i,t+k}) = 0 \tag{4}$$

then a regression on the investment ratio $(I_{i,t+k}/Y_{i,t+k})$ on the savings ratio $(S_{i,t+k}/Y_{i,t+k})$ must yield a zero coefficient β. Thus, the F-H criterion for perfect capital mobility of type IV requires a zero coefficient β in the following equation:

$$I_{i,t+k}/Y_{i,t+k} = \alpha + \beta(S_{i,t+k}/Y_{i,t+k}) + \epsilon_{i,t+k} \tag{5}$$

Equation (5) specifies the F-H criterion for testing the degree of capital mobility of type IV. Dooley et al. summarize these three covariances in the following equation (see also Table 1):[2]

$$\begin{aligned}\mathrm{Cov}(I_{i,t+k}/Y_{i,t+k}, S_{i,t+k}/Y_{i,t+k}) &= \mathrm{Cov}(\mu_i, S_{i,t+k}/Y_{i,t+k}) - \Phi\mathrm{Cov}(E_t(r^*_{i,t+k}), S_{i,t+k}/Y_{i,t+k}) \\ &\quad - \Phi\mathrm{Cov}(E_t(r_{i,t+k} - r^*_{i,t+k}), S_{i,t+k}/Y_{i,t+k}) = 0 \end{aligned} \tag{6}$$

Note that real interest parity is not required. If it is assumed as in our paper, (4) is automatically satisifed because the first variable in the covariance is nonstochastic. This means that, contrary to what is argued in the literature (e.g., Blundell-Wignall and Browne 1991), real interest parity is not a necessary condition for perfect capital mobility of type IV; it merely is a *sufficient* condition for perfect capital mobility of type IV. Furthermore, note that although the regression must yield a zero coefficient β, if (1)–(4) hold, a zero coefficient β can also be obtained if some terms cancel out.

The empirical and theoretical criticism that has been put forward against the F-H criterion is strongly related to above covariances, which represent the underlying assumptions of the F-H criterion. Therefore, we briefly analyze these covariances (see, e.g., Tesar 1991 for a review).

With reference to the last covariance: *Imperfect financial and/or nonfinancial capital mobility, which means* $Cov(E_t(r_{i,t+k} - r^*_{i,t+k}), S_{i,t+k}/Y_{i,t+k}) \neq 0$. It is very difficult to infer from the F-H results something about the degree of capital mobility of type II, which represents the ability and the willingness to move financial assets across national borders in response to expected differences in exchange-adjusted returns. The identification problem of the F-H criterion with respect to financial integration either in cross-section or in time-series analysis is a serious problem (Obstfeld 1986). Recall that RIP is a sufficient condition for perfect capital mobility of type IV, which means that the ex ante real interest differential is zero: $E_t[r_{t+k} - r^*_{t+k}] = [i_{t,t+k} - i^*_t - (f_t^{t+k} - s_t)] + [(f_t^{t+k} - s_t) - (E_t(s_{t+k} - s_t)] + [E_t(s_{t+k} - p_{t+k} + p^*_{t+k}) - (s_t - p_t + p^*_t)] = 0$. RIP simply may not hold because ex ante purchasing power parity may not hold. Consequently, an increase in institutional restrictions on labor mobility, on physical capital mobility, or on trade in goods and services may cause positive correlation between the savings and investment ratios, which may well go together with increasing financial integration. Nonetheless, as we will see in sections 4 and 5, the pattern of cross-sectional and time-series correlations seems consistent with an increasing degree of financial integration in the EC.

Sinn (1992, p. 1165) criticizes the cross-sectional estimation procedure of the F-H condition. Sinn argues: "Since saving and investment shares are approximately equal if averaged over the adjustment period, a correlation coefficient calculated from average savings and investment shares is likely to be higher than one that is not." Even with perfect capital mobility, high positive cross-sectional correlation may arise when savings and investment ratios are averaged over very long periods of time. That is, cross-sectional analysis causes an upward bias to the coefficient β. A country may run a current account deficit for a short period of time, but current account imbalances must accumulate to zero over a long period of time unless the country defaults on its foreign debt. Consequently, savings and investment ratios eventually are expected to move together. Sinn continues: "It would erroneously signal a low degree of international capital mobility because it ignores net capital flows that have occurred in reverse directions during the period over which averages are taken." *Gross* (two-way) financial and nonfinancial capital mobility may well be higher (see also Golub 1990, p. 428). However, the F-H criterion only examines *net* financial and nonfinancial capital mobility.

Wong (1990, p. 61–62) comments on another deficiency of the cross-sectional estimation of the F-H criterion. The cross-sectional correlation between savings and investment may be rather sensitive to the inclusion c.q. exclusion of particular countries in the sample. Wong points out that outliers may significantly bias the result when cross-sectional country averages are calculated.

Finally, we would like to make one last comment on the interpretation of the coefficient β. Feldstein and Bacchetta (1989, p. 10–11) give an important interpretation of the cross-sectional savings and investment correlations. The coefficient β not only refers to the degree of capital mobility among (a group of) EC countries but also the degree of capital mobility among (a group of) EC countries and the rest of the world, which of course also include countries like the United States and Japan. The same holds for the time-series interpretation of correlations between savings and investment ratios of individual EC countries.

With reference to the second covariance: *The foreign expected real interest rate is endogenous, which means* $Cov(E_t(r^*_{i,t+k}), S_{i,t+k}/Y_{i,t+k}) \neq 0$. The second covariance says that savings and investment ratios may be correlated even in the presence of perfect capital mobility of type III because of the effect of country size. The first interpretation of the country-size argument is as follows. Small countries take the world interest rate as given, while changes in savings and investment behavior of large countries will have an impact on the world interest rate (Tesar 1991, p. 68).[3] The second interpretation of the country-size argument follows from Harberger (1980). Harberger argues that in small less diversified countries, savings and investment shocks do not compensate each other, while in highly diversified countries this does happen. When a country becomes larger it also becomes more diversified and the need to borrow from abroad in the event of a shock declines. Differences between savings and investment are therefore greater in small than in large countries. These greater differences, however, do not mean that the degree of capital mobility of type IV is higher.

With reference to the first covariance: *S and I are endogenous, which means* $Cov(\mu_i, S_{i,t+k}/Y_{i,t+k}) \neq 0$. Even with perfect capital mobility of type III, savings and investment ratios may be positively correlated for reasons unrelated to capital mobility. This simultaneity of savings and investment ratio arises especially in time-series analysis, but may also arise in cross-section analysis. The stochastic error term μ_i that captures all other determinants of the investment rate, other than the ex ante real interest rate of that country, may be correlated with the savings ratio in that country. Private sector behavior such as business cycles, productivity shocks, and population growth may cause positive correlations. Obstfeld (1986), for example, argues that the growth rate of income may simultaneously affect savings and investment. Not only private sector behavior but also public sector behavior may cause savings and investment to be positively correlated. For example, government, which aims at long-term current account balance, reacts to a current account deficit arising from growing investment by raising taxes or lowering spending (Westphal 1983, Tobin 1983, Fieleke 1982, and Summers 1988). A government may also use policy instruments to balance savings and invesment of the private sector in light of its current account target. Artis and Bayoumi (1991, p. 301) note that common cause variations in savings and investment of the private and public sectors (positively correlated shocks), or inversely correlated shocks to public and private balances, will suffice to induce a high correlation between total savings and investment. In a short-run context structural factors are likely to affect both savings and investment more than in a long-run context. Dooley et al. (1987,

p. 508) argue: "*Any* economic variable, in addition to the cost of capital that influences the investment rate, will probably be correlated with the national saving rate."

An econometric solution to the endogeneity problem of savings and investment ratios is offered by the use of instrumental variables. Instrumental variable estimation requires an instrumental variable that is highly correlated with the savings ratio ($S_{i,t+k}/Y_{i,t+k}$) and uncorrelated with the error term ($\epsilon_{i,t+k}$). However, these 2SLS-estimates of the coefficient β do not particularly differ from OLS-estimates (Dooley et al. 1987, p. 518). In section 4, however, we will introduce the concept of cointegration to solve the endogeneity problem.

In summary, the interpretation of the F-H criterion depends heavily on three covariances, which must be zero before no correlation between savings and investment ratios would be expected. Therefore, the interpretation of the F-H criterion must be done with caution.

3. The Feldstein-Horioka criterion and cross-section analysis

The annual data employed in this section are taken from the OECD (1992), National Accounts of OECD countries, Main Aggregates 1960–1990, Volume I. A nonzero statistical discrepancy is split equally between savings and investment (see Appendix). The sample period 1967–1990 is divided into two equal subperiods: 1967–1978 and 1979–1990. The division reflects the formation of the European Monetary System (EMS), and the establishment of the Exchange Rate Mechanism (ERM) and the European Currency Unit (ECU) in 1979. Ratios of savings and investment to GDP for individual EC countries are averaged over time to avoid bias caused by the correlation of savings and investment over the business cycle.

Figure 1 plots average savings and investment ratios over the subperiods 1967–1978 and 1979–1980 for EC countries (excluding Luxembourg) similar to Tesar (1991, p. 61). The interpretation of Figure 1 runs as follows. An observation on

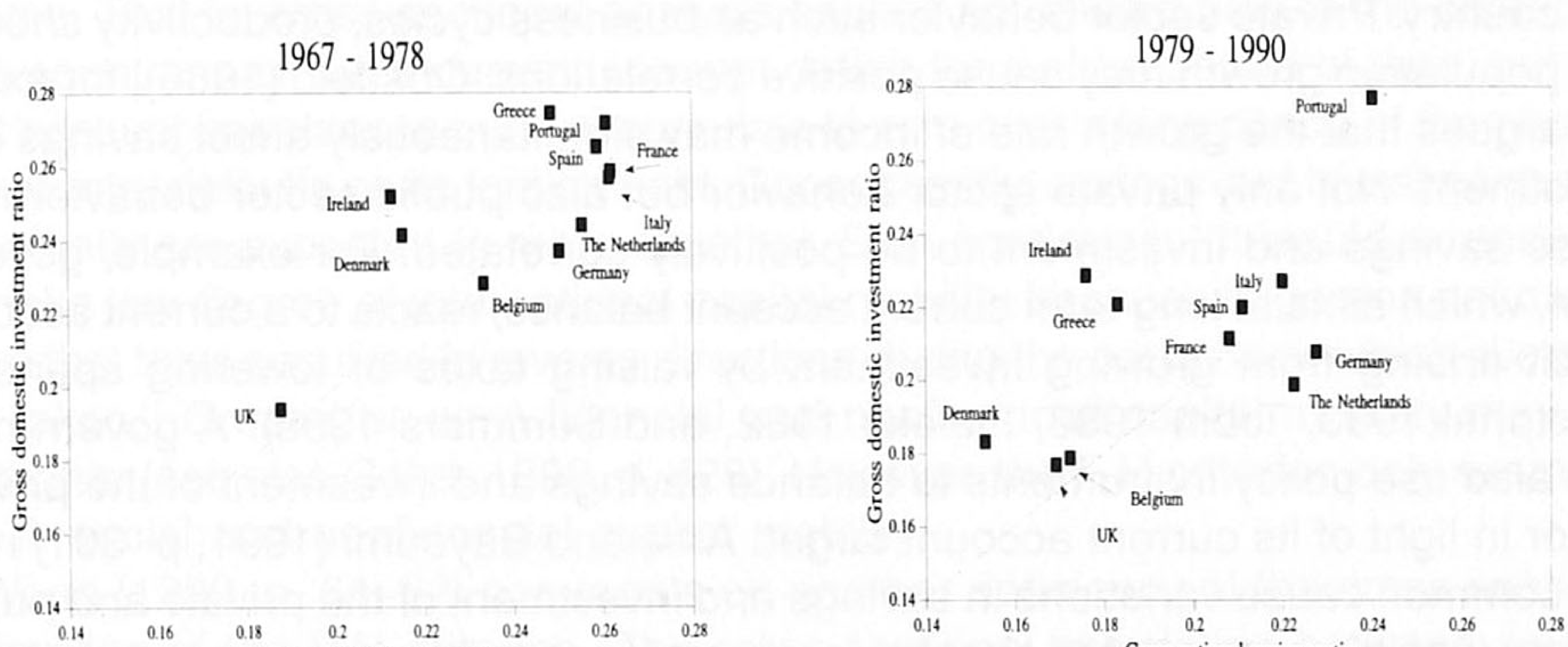

Figure 1. Average gross national savings vs. gross domestic investment ratios over the period 1967–1978 and 1979–1990 of EC countries (excluding Luxembourg).

the 45° line indicates that the country's current account is balanced, i.e., the country's domestic investment equals its supply of national savings. An observation below the 45° line reflects a current account deficit, i.e., the country's domestic investment exceeds its supply of national savings and the country is a net borrower in the international capital market (Tesar 1991, p. 61). An observation below the 45° line reflects a current account surplus. National savings exceed domestic investment. The country must have a corresponding capital account deficit (i.e., a capital outflow). The capital account is simply the inverse of the current account.

The F-H criterion for testing the degree of financial integration in the EC with cross-section data can be specified as follows:

$$I_{i,t+k}/Y_{i,t+k} = \alpha + \beta(S_{i,t+k}/Y_{i,t+k}) + \epsilon_{i,t+k} \tag{7}$$

where $\epsilon_{i,t+k}$ stands for the error term and i stands for the country index. F-H converts gross national savings $[S_{i,t+k}]$ and gross domestic investment $[I_{i,t+k}]$ into relative form by dividing by gross domestic product $[Y_{i,t+k}]$. The coefficient β is called the "savings retention coefficient" and indicates the proportion of the incremental savings that is invested domestically (Feldstein and Bacchetta 1989, p. 10). When financial markets are not integrated, the current account is forced to balance and the coefficient β should be unity. With perfect capital mobility of type IV a zero value of β is predicted.

We distinguish two cross-section samples of European countries. The first sample consists of nine EC member states excluding Greece, Portugal, and Luxembourg (EC-9). The second sample consists of six core ERM countries: Germany, France, Italy, Belgium, Denmark, and the Netherlands (ERM-6). Cross-section analysis may not be useful if there are significant differences between the correlation of savings and investment ratios across EC countries. This is why we exclude Portugal and Greece (assuming high correlation) and Luxembourg (assuming low correlation) from our sample. The scatter plots in Figure 1 show that Portugal and Greece probably have an "outlier" effect on the results. Luxembourg even lies out of the range of the graph. Furthermore, Greece is the only EC member state in which national accounting definitions of savings and investment are based on the earlier SNA definitions (see Appendix). Greece almost certainly has less claim to be included among the EC-9 countries than either Spain or Portugal. We estimated the standard cross-section specification of the F-H criterion in level form for EC-9 and ERM-6 countries with OLS. The results are summarized in Table 2.

The results for the EC-9 countries in Table 2 show a decline in the estimated value of β in the period 1979–1990 relative to the period 1967–1978, indicating an increasing degree of capital mobility of type IV. Following Feldstein and Horioka (1980) and Feldstein (1983), we simultaneously test the null hypothesis $H_0\ \beta = 0$ against the alternative hypothesis $H_1\ \beta \neq 0$ and the null hypothesis $H_0\ \beta = 1$ against the alternative hypothesis $H_1\ \beta \neq 1$ at the 5% level of significance.[4] The results for the EC-9 show that the coefficient β is imprecisely estimated in period 1967–1990. The coefficient β is significantly different from zero and insignificantly different from one in the subperiod 1967–1978. We statistically speak of perfect capital immobility of type IV in the subperiod 1967–1978. The coefficient β is

Table 2. The F-H criterion and cross-section analysis
(OLS estimation of equation $I_{i,t+k}/Y_{i,t+k} = \alpha + \beta(S_{i,t+k}/Y_{i,t+k}) + \epsilon_i$, EC-9 and ERM-6)

	EC-9			ERM-6		
Period (t)	$\hat{\alpha}$	$\hat{\beta}$	$\bar{R}^2$	$\hat{\alpha}$	$\hat{\beta}$	$\bar{R}^2$
1967–1990	0.12	0.49†	0.34	0.13	0.44*	0.43
	(0.05)	(0.22)		(0.05)	(0.20)	
1967–1978	0.10	0.60	0.51	0.15	0.40*	0.25
	(0.05)	(0.20)		(0.06)	(0.25)	
1979–1900	0.12	0.42*	0.23	0.11	0.47‡	0.52
	(0.05)	(0.23)		(0.04)	0.18)	

Notes:
*Indicates that the coefficient β is insignificantly different from zero and significantly different from one at the 5% level of significance.
†Indicates that the coefficient β is imprecisely estimated and differs insignificantly from zero and insignificantly from one at the 5% level of significance.
‡Indicates that the coefficient β is imprecisely estimated and differs significantly from zero and significantly from one at the 5% level of significance.
Standard errors are shown in parentheses.
Source: OECD (1992), National Accounts of OECD Countries, Main Agrregates 1960–1990, Volume I.

insignificantly different from zero and significantly different from one in the subperiod 1979–1990. The assumption of perfect capital mobility of type IV cannot be rejected according to the F-H criterion in the subperiod 1979–1990. This result is also illustrated in Figure 1 by the greater dispersion of points around the 45° line in the subperiod 1979–1990 relative to the subperiod 1967–1978. Nevertheless, it is questionable if all assumptions underlying the F-H criterion for perfect capital mobility are met. To accept the null hypothesis of perfect capital mobility of type IV ($H_0\ \beta = 0$) we require all three covariances set out in section 2 to be zero or at least to cancel out.

In general, the ERM-6 estimates for β are smaller than the EC-9 estimates. We may conclude that capital mobility of type IV between ERM-6 countries is higher than between EC-9 countries. It seems that the ERM-6 countries are already substantially integrated. This may be accounted for by the lack of currency risk and by the strong interdependence of their economies.[5] The results for the ERM-6, however, show a rise in the estimated value of β in the period 1979–1990 relative to the period 1967–1978, indicating a decreasing degree of capital mobility of type IV. The apparent higher correlation in the period 1979–1990 relative to 1967–1978 for the ERM-6 may be explained by emerging investment opportunities in Europe after the formation of the EMS in 1979 (Obstfeld 1989, p. 151). The formation of the EMS in 1979 and the subsequent preparation for the Economic and Monetary Union (EMU), may have caused a pattern of investment increases only partly financed by foreign savings. Santillán (1991, p. 33) argues: "Efforts to stimulate savings and enhance its allocation across countries are at the heart of the process towards Economic and Monetary Union." The higher values in the latter period simply may be due to the fact that, within the ERM-6 countries, markets became so integrated that there was little need for capital flows to and from the rest of the world (see Leachman 1991, p. 159).

As was explained in section 2, the results obtained from F-H regressions are hard to interpret. The upward bias to savings-investment correlations for the ERM-6, however, bears no relation to increased financial integration in the European Community. Although it is difficult to interpret savings-investment correlations, the apparent lower cross-sectional savings-investment correlation for European financial markets do challenge the view that was usually found for world financial markets. Results obtained by Bhandari and Mayer (1990) have confirmed the higher degree of capital mobility among EMS countries than among other industrial countries. Most savings-investment correlations are sufficiently far from the value of unity to conclude that financial markets are not closed. Furthermore, the cross-sectional β coefficients simply reflect capital mobility between a sample of countries taken as a unit to and from the rest of the world, not capital mobility between individual EC countries (Leachman, 1991, p. 158). A high statistical correlation between savings and investment ratios based upon a sample of EC countries does not necessarily indicate a low degree of capital mobility of type IV for each individual EC country. In fact, cross-section analysis assumes the same degree of capital mobility for each individual country in the sample. Therefore, the next section turns to time-series analysis of savings-investment correlations of individual EC countries.

4. The Feldstein-Horioka criterion and time-series analysis

In the previous section we performed cross-section analyses for a sample of six and nine EC countries to eliminate the procyclical nature of savings and investment even when expressed as a fraction of gross domestic product. This section performs time-series analysis with the help of cointegration tests. Cointegration in the context of the F-H criterion deals with the long-run relationship between savings and investment ratios. The application of cointegration requires savings and investment ratios to be nonstationary (Engle and Granger 1987). The original test for unit roots in economic time series was developed by Fuller (1976) and Dickey and Fuller (1979). We have performed augmented Dickey-Fuller (ADF) tests with a constant term included because savings and investment ratios have nonzero means. A regression model (with drift) is used to test for a unit root in $X_{t+k,i} = (I_{t+k,i}/Y_{t+k,i}, S_{t+k,i}/Y_{t+k,i})$:

$$\Delta X_{t+k,i} = \alpha + \pi X_{t+k-1,i} + \sum_{j=1}^{8} \gamma \Delta (X_{t+k-j,i}) + \mu_{t+k,i} \tag{8}$$

where α is the constant drift and $\mu_{t+k,i}$ is a white noise error term. The null hypothesis states that $I_{t+k,i}/Y_{t+k,i}$ respectively $S_{t+k,i}/Y_{t+k,i}$ are nonstationary c.q. have a unit root that is rejected when π is significantly negative. A constant has been included since $I_{t+k,i}/Y_{t+k,i}$ and $S_{t+k,i}/Y_{t+k,i}$ have a nonzero mean. Furthermore, we include the minimum number of lags necessary to ensure that the residuals $\mu_{t+k,i}$

are white noise (see De Haan and Siermann 1994, p. 7). Possible serial correlation of $\mu_{t+k,i}$ in the regression models is corrected for up to eighth-order lags. Critical values for the ADF test are tabulated in Fuller (1976, p. 373).

We are aware that drawing reliable inference from the outcome of the ADF-test may be problematic due to the limited number of observations when annual data are used. The problem is partly overcome because of the long 12- and 24-year spans of data we examine. Hakkio and Rush (1990) argue that what is relevant for determining long-run relationships is the length of the data set, not the frequency. In fact, increasing the data frequency adds very little to the inference. OECD quarterly data on savings and investment ratios of EC countries are only available for Germany, the United Kingdom, and France from 1970 onward.

Table 3 summarizes the outcomes of the ADF-tests. We may safely conclude from Table 3 that, in general, savings and investment ratios are nonstationary. Therefore cointegration tests are warranted. Only for Italy (1967–1978), Ireland (1967–1978), and Portugal (1967–1990, 1979–1990), nonstationarity of one or both series was rejected.

Cointegration between savings and investment ratios implies the existence of a dynamic error correction model c.q. a long-run equilibrium relationship (see Engle and Granger, 1987). The current account c.q. the capital account balances over long periods of time, and savings and investment ratios move together. The cointegrating regression equation is specified as follows:

$$I_{t+k,i}/Y_{t+k,i} = \alpha + \beta(S_{t+k,i}/Y_{t+k,i}) + \epsilon_{t+k,i} \tag{9}$$

A valid error-correction representation of (8) may then be specified in the following way (see also Jansen and Schulze 1993):

$$\Delta(I/Y)_{t+k,i} = \alpha + \beta\,\Delta(S/Y)_{t+k,i} + \gamma[(I/Y)_{t+k-1,i} - \delta(S/Y)_{t+k-1,i}] + \eta_{t+k,i} \tag{10}$$

where β is the impact multiplier, γ is the error correction coefficient, δ is the long-run multiplier and $[(I/Y)_{t+k-1,i} - \delta(S/Y)_{t+k-1,i}]$ is the error correction term. Cointegration simply implies that the above error correction representation exists.

We consider three common tests for cointegration. A first benchmark for cointegration is the Durbin-Watson statistic from the cointegrating regression Durbin-Watson (CRDW), developed by Sargan and Bhargava (1983) and Bhargava (1986). Lower and upper limit critical values for the CRDW test depending on the regressors in (9) are tabulated by Bhargava (1986, p. 378). We reject the null hypothesis of a unit root in the residuals (H_0 DW $= 0$, i.e., no cointegration) when the value of the CRDW test exceeds its 5% critical value. Instead of the CRDW test we also apply an ADF test to the residuals from the cointegrating regression (Engle and Granger 1987). We estimate equation (9) with OLS for all 12 EC countries and save the residuals. Subsequently, we perform an ADF test similar to the previous ADF test on the savings and investment ratios. Again the null hypothesis of a unit root in the residuals (i.e., no cointegration) is rejected if the value of the ADF test exceeds its 5% critical value. Consequently, the null hypothesis of no cointegration

Table 3. Testing for a unit root in $I_{t+k,i}/Y_{t+k,i}$ and $S_{t+k,i}/Y_{t+k,i}$ of 12 EC member states[a]

	1967–1990	1967–1978	1979–1990
Germany			
$I_{t+k,i}/Y_{t+k,i}$	ADF(0) = − 1.32(− 3.00)	ADF(0) = − 0.76(− 3.18)	ADF(0) = − 1.99(− 3.18)
$S_{t+k,i}/Y_{t+k,i}$	ADF(0) = − 1.27(− 3.00)	ADF(0) = − 0.74(− 3.18)	ADF(0) = − 0.45(− 3.18)
United Kingdom			
$I_{t+k,i}/Y_{t+k,i}$	ADF(0) = − 2.11(− 3.00)	ADF(0) = − 2.59(− 3.18)	ADF(1) = − 2.50(− 3.22)
$S_{t+k,i}/Y_{t+k,i}$	ADF(0) = − 1.45(− 3.00)	ADF(0) = − 1.52(− 3.18)	ADF(0) = − 2.39(− 3.18)
France			
$I_{t+k,i}/Y_{t+k,i}$	ADF(0) = − 1.28(− 3.00)	ADF(0) = − 1.71(− 3.18)	ADF(0) = − 1.63(− 3.18)
$S_{t+k,i}/Y_{t+k,i}$	ADF(0) = − 0.98(− 3.00)	ADF(0) = − 0.98(− 3.18)	ADF(0) = − 2.79(− 3.18)
The Netherlands			
$I_{t+k,i}/Y_{t+k,i}$	ADF(0) = − 1.64(− 3.00)	ADF(0) = − 0.88(− 3.18)	ADF(0) = − 1.59(− 3.18)
$S_{t+k,i}/Y_{t+k,i}$	ADF(0) = − 1.45(− 3.00)	ADF(0) = − 0.13(− 3.18)	ADF(0) = − 0.76(− 3.18)
Italy			
$I_{t+k,i}/Y_{t+k,i}$	ADF(0) = − 2.02(− 3.00)	ADF(0) = − 3.31(− 3.18)	ADF(0) = − 1.12(− 3.18)
$S_{t+k,i}/Y_{t+k,i}$	ADF(0) = − 0.12(− 3.00)	ADF(0) = − 1.81(− 3.18)	ADF(0) = − 2.70(− 3.18)
Belgium			
$I_{t+k,i}/Y_{t+k,i}$	ADF(0) = − 1.35(− 3.00)	ADF(0) = − 2.77(− 3.18)	ADF(0) = − 1.44(− 3.18)
$S_{t+k,i}/Y_{t+k,i}$	ADF(0) = − 1.16(− 3.00)	ADF(0) = − 1.02(− 3.18)	ADF(0) = − 0.23(− 3.18)
Ireland			
$I_{t+k,i}/Y_{t+k,i}$	ADF(0) = − 1.58(− 3.00)	ADF(0) = − 2.36(− 3.18)	ADF(0) = − 2.36(− 3.18)
$S_{t+k,i}/Y_{t+k,i}$	ADF(0) = − 1.73(− 3.00)	ADF(0) = − 3.55(− 3.18)	ADF(0) = − 0.74(− 3.18)
Spain			
$I_{t+k,i}/Y_{t+k,i}$	ADF(0) = − 1.16(− 3.00)	ADF(1) = − 1.57(− 3.22)	ADF(1) = − 1.57(− 3.22)
$S_{t+k,i}/Y_{t+k,i}$	ADF(0) = − 0.86(− 3.00)	ADF(0) = − 1.67(− 3.18)	ADF(0) = − 1.67(− 3.18)
Denmark			
$I_{t+k,i}/Y_{t+k,i}$	ADF(0) = − 1.18(− 3.00)	ADF(0) = − 1.80(− 3.18)	ADF(1) = − 2.29(− 3.22)
$S_{t+k,i}/Y_{t+k,i}$	ADF(1) = − 1.67(− 3.00)	ADF(0) = − 0.61(− 3.18)	ADF(0) = − 0.60(− 3.18)
Portugal			
$I_{t+k,i}/Y_{t+k,i}$	ADF(1) = − 3.85(− 3.00)	ADF(0) = − 1.92(− 3.18)	ADF(1) = − 4.19(− 3.18)
$S_{t+k,i}/Y_{t+k,i}$	ADF(1) = − 3.27(− 3.00)	ADF(1) = − 2.21(− 3.22)	ADF(0) = − 1.35(− 3.18)
Greece			
$I_{t+k,i}/Y_{t+k,i}$	ADF(0) = − 1.28(− 3.00)	ADF(0) = − 2.08(− 3.18)	ADF(0) = − 2.59(− 3.18)
$S_{t+k,i}/Y_{t+k,i}$	ADF(0) = − 0.83(− 3.00)	ADF(0) = − 1.57(− 3.18)	ADF(0) = − 1.78(− 3.18)
Luxembourg			
$I_{t+k,i}/Y_{t+k,i}$	ADF(0) = − 2.75(− 3.00)	ADF(0) = − 1.74(− 3.18)	ADF(0) = − 1.95(− 3.18)
$S_{t+k,i}/Y_{t+k,i}$	ADF(0) = − 1.75(− 3.00)	ADF(0) = − 2.05(− 3.18)	ADF(0) = − 1.79(− 3.18)
	1970Q1–1990Q4	1970Q1–1978Q4	1979Q1–1990Q4
Germany			
$I_{t+k,i}/Y_{t+k,i}$	ADF(7) = − 2.66(− 2.90)	ADF(7) = − 1.64(− 2.97)	ADF(4) = − 2.34(− 2.92)
$S_{t+k,i}/Y_{t+k,i}$	ADF(6) = − 2.21(− 2.90)	ADF(4) = − 1.71(− 2.96)	ADF(4) = − 1.75(− 2.92)
United Kingdom			
$I_{t+k,i}/Y_{t+k,i}$	ADF(0) = − 1.59(− 2.90)	ADF(1) = − 1.95(− 2.95)	ADF(0) = − 1.83(− 2.92)
$S_{t+k,i}/Y_{t+k,i}$	ADF(2) = − 2.19(− 2.90)	ADF(0) = − 2.64(− 2.95)	ADF(1) = − 1.67(− 2.92)
France			
$I_{t+k,i}/Y_{t+k,i}$	ADF(0) = − 1.51(− 2.90)	ADF(1) = − 2.78(− 2.95)	ADF(0) = − 1.71(− 2.92)
$S_{t+k,i}/Y_{t+k,i}$	ADF(0) = − 1.51(− 2.90)	ADF(0) = − 1.27(− 2.95)	ADF(0) = − 2.33(− 2.92)

Note: ADF stands for the augmented Dickey-Fuller test with the number of lags used shown in parentheses. Critical values at 5% level of significance are shown in parentheses.

Sources: OECD (1992), National Accounts of OECD Countries, Main Aggregates 1960–1990, Volume I. OECD (1993), Quarterly National Accounts.

is rejected as well. Finally we apply a test developed by Johansen (1988) to discover a cointegrating relationship between savings and investment ratio over long periods of time. Although the Johansen test is a multivariate test, it is also possible to apply it to the two-dimensional case to discover a unique cointegrating vector, which may exist between savings and investment ratios. If the null hypothesis of H_0 $r = 0$ is rejected and H_0 $r \leq 1$ is accepted, we have cointegration. Further details are available in Johansen and Juselius (1990) and Johansen (1991). Table 4 reports all three statistics for testing cointegration with time-series savings and investment ratios for 12 EC countries when annual data are used, and for three EC countries when quarterly data are used. OLS standard errors for β are not reported because the OLS estimates corresponding to β values in equation (9) are small when savings and investment ratios are cointegrated. Consequently, testing H_0 $\beta = 1$ rejects too often (Stock 1987).

It is particularly interesting to compare the subperiods before and after the formation of the EMS in 1979. If all three tests reject no cointegration, we find the strongest evidence for cointegration of savings and investment ratios. Unfortunately, the simple CRDW test only works well with first-order autocorrelation in the error term of the cointegrating regression. The critical values for the ADF test of the residuals, however, are only slightly changed when higher autocorrelation is present. If both the ADF and the Johansen tests reject no cointegration, we still have strong evidence for cointegration of savings and investment ratios. However, the outcomes of the Johansen test for the subperiods probably have less weight due to the limited amount of data. The Johansen test is biased in small samples because it is based on asymptotic theory, and it probably rejects H_0 $r = 0$ (no cointegration) too often. Therefore, Engle and Granger recommend the ADF test of the residuals.

For the annual data at least two tests reject no cointegration between savings and investment ratios for the United Kingdom (1967–1978), France (1967–1990, 1967–1979), Italy (1967–1990), Spain (1967–1990), Denmark (1967–1978), Portugal (1979–1990), and Greece (1967–1990, 1967–1978, 1979–1990). Clearly, Greece comes out as the least open EC country. No cointegration is accepted by at least two tests for Germany (1967–1990, 1967–1978, 1979–1990), the United Kingdom (1967–1990, 1979–1990), France (1979–1990), the Netherlands (1967–1990, 1967–1978, 1979–1990), Italy (1979–1990), Ireland (1967–1990, 1967–1978, 1979–1990), Spain (1967–1978, 1979–1990), Denmark (1967–1990, 1979–1990), Portugal (1967–1990, 1967–1978), and Luxembourg (1967–1990, 1967–1978, 1979–1990). If we compare only the outcomes of the recommended ADF test with its critical value, the null hypothesis of a unit root in the residuals cannot be rejected for Germany, the Netherlands, Belgium, Ireland, and Luxembourg in all three periods. Probably these countries belong to the group of EC countries with the highest degree of capital mobility of type IV.

For the quarterly data at least two tests reject no cointegration between savings and investment ratios for France (1970Q1–1990Q4, 1970Q1–1978Q4) and Germany (1970Q1– 1990Q4, 1979Q1–1990Q4). At least three tests accept no cointegration for the United Kingdom (1970Q1–1990Q4, 1970Q1–1978Q4, 1970Q1–1978Q4), France (1979Q1–1990Q4, 1970Q1–1978Q4), and Germany 1970Q1–

Table 4. The F-H Criterion and time-series analysis (Testing for cointegration between $I_{t+k,i}/Y_{t+k,i}$ and $S_{t+k,i}/Y_{t+k,i}$)

Period (t)	$\hat{\alpha}$	$\hat{\beta}$	$\bar{R}^2$	CRDW	ADF test of residuals	Johansen test H_0 r =0, H_1 r = 1	Johansen test H_0 r ≤ 1, H_1 r =2
Germany							
1967–1990	0.03	0.81	0.60	0.37	ADF(0) = − 1.36(− 3.00)	5.16(15.75)	2.01(9.09)
1967–1978	− 0.01	1.00	0.91	1.09	ADF(0) = − 2.16(− 3.18)	37.69(15.75)	47.95(9.09)
1979–1990	0.19	0.10	− 0.08	0.50	ADF(0) = − 2.01(− 3.18)	17.97(15.75)	9.79(9.09)
United Kingdom							
1967–1990	0.14	0.26	0.02	0.62	ADF(0) = − 1.94(− 3.00)	57.78(15.75)	4.56(9.09)
1967–1978	0.15	0.22	0.01	1.58	ADF(1) = − 3.42(− 3.22)	16.32(15.75)	2.81(9.09)
1979–1990	0.27	− 0.54	0.03	0.85	ADF(1) = − 3.03(− 3.22)	40.81(15.75)	3.07(9.09)
France							
1967–1990	0.03	0.88	0.93	1.81	ADF(0) = − 4.18(− 3.00)	19.41(15.75)	2.70(9.09)
1967–1978	0.02	0.92	0.68	2.27	ADF(0) = − 3.68(− 3.18)	12.82(15.75)	1.77(9.09)
1979–1990	0.03	0.87	0.81	1.14	ADF(0) = − 2.16(− 3.18)	31.39(15.75)	11.89(9.09)
The Netherlands							
1967–1990	0.00	0.92	0.61	0.50	ADF(1) = − 2.58(− 3.00)	6.69(15.75)	3.20(9.09)
1967–1978	0.03	0.86	0.53	0.60	ADF(0) = − 1.36(− 3.18)	29.76(15.75)	2.83(9.09)
1979–1990	0.15	0.21	− 0.01	0.71	ADF(0) = − 2.00(− 3.18)	33.39(15.75)	8.73(9.09)
Italy							
1967–1990	0.07	0.72	0.60	1.40	ADF(0) = − 3.44(− 3.00)	16.79(15.75)	4.28(9.09)
1967–1978[a]	0.14	0.44	− 0.03	1.69	ADF(0) = − 2.63(− 3.18)	15.10(15.75)	7.63(9.09)
1979–1990	0.05	0.81	0.64	1.57	ADF(1) = − 2.68(− 3.22)	11.61(15.75)	3.37(9.09)
Belgium							
1967–1990	0.06	0.69	0.70	0.55	ADF(0) = − 1.81(− 3.00)	6.31(15.75)	1.72(9.09)
1967–1978	0.16	0.28	0.15	2.01	ADF(0) = − 3.06(− 3.18)	11.26(15.75)	3.64(9.09)
1979–1990	0.09	0.53	0.26	0.36	ADF(0) = − 1.56(− 3.18)	20.27(15.75)	5.02(9.09)
Ireland							
1967–1990	0.20	0.20	− 0.03	0.39	ADF(0) = − 1.60(− 3.00)	21.49(15.75)	1.58(9.09)
1967–1978[b]	0.18	0.33	− 0.08	1.07	ADF(0) = − 2.69(− 3.18)	8.53(15.75)	5.49(9.09)
1979–1990	0.29	− 0.34	− 0.07	0.31	ADF(0) = − 2.63(− 3.18)	17.44(15.75)	4.03(9.09)
Spain							
1967–1990	0.04	0.89	0.67	0.71	ADF(2) = − 4.03(− 3.01)	37.03(15.75)	10.56(9.09)
1967–1978	0.11	0.59	0.19	1.00	ADF(0) = − 1.45(− 3.18)	16.78(15.75)	4.17(9.09)
1979–1990	0.03	0.91	0.24	0.55	ADF(0) = − 2.04(− 3.18)	70.73(15.75)	19.95(9.09)
Denmark							
1967–1990	0.06	0.85	0.83	1.18	ADF(0) = − 2.48(− 2.99)	47.14(15.75)	6.20(9.09)
1967–1978	0.10	0.64	0.59	2.50	ADF(1) = − 4.24(− 3.22)	4.42(15.75)	1.46(9.09)
1979–1990	0.10	0.56	0.26	0.93	ADF(0) = − 1.75(− 3.18)	13.36(15.75)	10.14(9.09)
Portugal							
1967–1990[c]	0.21	0.26	0.08	0.66	ADF(1) = − 3.24(− 3.00)	14.81(15.75)	5.91(9.09)
1967–1978	0.20	0.27	0.23	1.03	ADF(0) = − 1.59(− 3.18)	32.11(15.75)	8.76(9.09)
1979–1990[a]	0.20	0.36	− 0.03	0.56	ADF(1) = − 3.76(− 3.22)	31.03(15.75)	5.48(9.09)
Greece							
1967–1990	0.09	0.75	0.89	1.50	ADF(0) = − 4.26(− 3.00)	30.46(15.75)	7.19(9.09)
1967–1978	0.00	0.97	0.85	1.60	ADF(0) = − 3.69(− 3.18)	10.69(15.75)	1.29(9.09)
1979–1990	0.10	0.64	0.86	1.72	ADF(0) = − 3.02(− 3.18)	63.69(15.75)	6.55(9.09)
Luxembourg							
1967–1990	0.23	0.04	− 0.02	1.00	ADF(0) = − 2.74(− 3.00)	16.24(15.75)	3.07(9.09)
1967–1978	0.18	0.15	− 0.03	0.99	ADF(0) = − 1.77(− 3.18)	19.51(15.75)	10.65(9.09)
1979–1990	0.25	0.00	− 0.10	1.15	ADF(0) = − 1.95(− 3.18)	32.01(15.75)	2.62(9.09)

Table 4. Continued.

Period (t)	$\hat{\alpha}$	$\hat{\beta}$	$\bar{R}^2$	CRDW	ADF test of residuals	Johansen test H_0 r =0, H_1 r = 1	Johansen test H_0 r ≤ 1, H_1 r =2
Germany							
1970Q1–1990Q4	0.12	0.83	0.68	1.09	ADF(5) = −2.77(−2.90)	20.23(15.75)	4.84(9.09)
1970Q1–1978Q4	0.10	1.01	0.90	1.53	ADF(8) = −1.70(−2.90)	8.52(15.75)	6.37(9.09)
1979Q1–1990Q4	0.15	0.53	0.21	1.31	ADF(5) = −2.83(−2.93)	28.97(15.75)	2.80(9.09)
United Kingdom							
1970Q1–1990Q4	0.01	1.00	0.49	0.28	ADF(0) = −2.76(−2.90)	7.31(15.75)	4.67(9.09)
1970Q1–1978Q4	0.07	0.78	0.21	0.28	ADF(0) = −2.04(−2.95)	14.77(15.75)	3.81(9.09)
1979Q1–1990Q4	0.06	0.72	0.27	0.21	ADF(0) = −1.66(−2.95)	16.53(15.75)	1.39(9.09)
France							
1970Q1–1990Q4	0.03	0.86	0.89	0.53	ADF(0) = −3.50(−2.90)	22.28(15.75)	4.13(9.09)
1970Q1–1978Q4	0.02	0.92	0.67	0.48	ADF(1) = −3.19(−2.95)	26.38(15.75)	3.02(9.09)
1979Q1–1990Q4	0.03	0.87	0.76	0.59	ADF(0) = −2.92(−2.92)	13.30(15.75)	10.73(9.09)

Notes:
[a]For $I_{t+k,i}/Y_{t+k,i}$ the null hypothesis of a unit root was rejected in Table 3.
[b]For $S_{t+k,i}/Y_{t+k,i}$ the null hypothesis of a unit root was rejected in Table 3.
[c]Both for $I_{t+k,i}/Y_{t+k,i}$ and $S_{t+k,i}/Y_{t+k,i}$ the null hypothesis of a unit root was rejected in Table 3.
The approximate CRDW critical values for the random walk model with constant drift at 5% level of significance are 1.21 (1967–1990), 1.45 (1967–1978 and 1979–1990), 0.43 (1970Q1–1990Q4), 0.91 (1970Q1–1978Q4), and 0.66 (1979Q1–1990Q4).
Critical values for the ADF and the Johansen tests at 5% level of significance are shown in parentheses.

1978Q4). The United Kingdom probably has the highest degree of capital mobility of type IV, followed by Germany and France. Germany is placed before France because the recommended ADF test with respect to Germany does not reject in all three periods, while with respect to France it rejects two times. The ADF test for the United Kingdom does not reject in all three periods.

Comparing the results for Germany, France, and the United Kingdom with quarterly and yearly data, the values of the CRDW of the United Kingdom and France decline substantially, while those of Germany increase substantially. Both the CRDW and the Johansen test frequently conclude the opposite for Germany, the United Kingdom, and France when quarterly data as opposed to annual data are used. However, generally, we are able to draw the same conclusion from the ADF test when quarterly data or annual data are used. Therefore the ADF test is to be preferred. In the pre-1979 period, savings and investment ratios were cointegrated in the United Kingdom, France, Denmark, and Greece. For the post-1979 period, the ADF test only finds cointegration between savings and investment ratios for Portugal. In summary, the degree of capital mobility of type IV has increased since 1979. The empirical results seem consistent with an increasing degree of capital mobility of type IV in the 1980s.

5. Conclusions

It is difficult to accept that most evidence from savings-investment correlations with respect to a sample of OECD countries often contradicts the finding of high capital flows in world financial markets. We stress that much of these high correlations may be due to the underlying assumptions of the F-H criterion. In fact, we argue that the F-H criterion measures more than financial capital mobility alone.

The results for the cross-section of nine EC countries show an increasing degree of capital mobility of type IV in the 1980s. Moreover, the group of six ERM countries shows an even smaller estimate for the coefficient β. From the time-series analysis based on cointegration techniques, we conclude that savings and investment ratios in an increasing number of EC countries are not cointegrated. With capital mobility of type IV still increasing, we might expect more countries' savings and investment ratios not to be cointegrated.

From section 2 we know that departures from perfect capital mobility of type IV may be caused by investors who are risk averse with respect to exchange risk. Therefore, an important explanation for an increasing degree of financial integration in the EC may be the smoothing of exchange rate volatility. Bhandari and Mayer (1990) conclude ". . . it appears that the exchange rate stability achieved in the EMS has been an important factor promoting capital mobility." Feldstein and Bacchetta (1989) argue: "Although capital might be principle flow with equal ease among all countries or at least all industrial countries, the availability of market information, the existence of institutional relationships, and the perception of risk might make capital flows greater among some pairs of countries than among others." Another important explanation for an increasing degree of financial integration is the gradual elimination of all barriers to short-term and long-term capital mobility in the EC.

In summary, the F-H criterion has some meaning in quantifying the degree of financial integration in the European Community. Its value will further increase when it is examined in combination with related criteria for financial integration, such as the covered, uncovered, and real interest parity condition.

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Notes

1. Akhtar and Weiller (1987, p. 19) argue: "In practice, components of rates of return, e.g., exchange rates, may adjust quickly without actual movements of capital, that is, capital mobility may be just incipient."
2. The equation is based on the specification of the F-H criterion used with *cross-section* analysis. The equation could equally well be specified in a time-series context.

3. Large countries are countries with a large share of world output and probably have a large share in world savings and investment.
4. Obstfeld (1986, p. 66) argues: "Since the least-square estimate of β is not, strictly speaking, a correlation coefficient, there is no reason for it to be less than 1."
5. EC member states that participate in the ERM of the EMS during the period 1979–1990 are: Denmark, Germany, France, Italy, Ireland, Belgium, Luxembourg, and The Netherlands (as of March 13, 1979); Spain (as of June 16, 1989); the United Kingdom (as of October 8, 1990). Denmark, Germany, France, Ireland, Belgium, Luxembourg, and The Netherlands have a fluctuation margin of ±2.25%; Italy ±6% and as of January 8, 1990 ±2.25%; Spain and the United Kingdom ±6%. The United Kingdom and Italy temporarily suspended ERM participation on September 17,1992.

Appendix

Gross national savings, gross domestic investment, and gross domestic product

Data of gross national savings, gross domestic investment, and gross domestic product are taken from OECD (1992), National Accounts of OECD Countries, Main Aggregates 1960–1990, Volume I. Gross national savings, gross domestic investment, and gross domestic product are taken at current prices. The OECD-definitions of gross national savings, gross domestic investment, and gross domestic product of all EC member states except Greece are the ones used in the United Nations *Present* System of National Accounts (SNA). Definitions of Greece are based on an earlier system. The national accounting framework underlying the F-H criterion can be specified as follows:

$$\begin{aligned} S &= GNP - C + NCT \\ GNP &= C + I + X - M + NFI \\ S &= I + X - M + NFI + NCT \\ I &= FCF + ST \end{aligned}$$

Now, the current account of the balance of payments can be written as the balance of national savings and domestic investment.

$$\begin{aligned} S &= I + CA \\ CA &= S - I \end{aligned}$$

Furthermore, Artis and Bayoumi (1991) show that the current account can also be specified as the sum of private and public sector savings-investment balances.

$$CA = (S_p - I_p) + (S_g - I_g) = S - I$$

The statistical discrepancy is split equally between savings and investment so that the identity containing only the three aggregate variables—S, I, and the CA—holds exactly across all countries.

$$CA = (S + 1/2 * \text{statistical discrepancy}) - (I - 1/2 * \text{statistical discrepancy})\ CA = S' - I'$$

EC countries reporting a nonzero value for the statistical discrepancy include: United Kingdom, The Netherlands, Italy, Spain, and Portugal.

Following Feldstein and Horioka (1980), gross national savings and gross domestic investment are converted into relative form by dividing by gross domestic product.

$$Y = GNP + NCT$$

Symbols:

S = gross national savings
I = gross domestic investment
C = total private and government final consumption expenditure
M = import of goods and services
X = export of goods and services
Y = gross domestic product
CA = current account of the balance of payments
GNP = gross national product
NCT = net current transfers from the rest of the world
NFI = net factor income from the rest of the world
FCF = gross fixed capital formation
ST = increase in stocks
S_p = gross national savings by the private sector
S_g = gross national savings by the public sector
I_p = gross domestic investment by the private sector
I_g = gross domestic investment by the government sector
$'$ = corrected for a nonzero value of the statistical discrepancy

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